

**REMARKS**

Claims 1, 2 and 13 have been amended to recite 0 to 75% by weight of a compound having two epoxy groups in the molecule and 100 to 25% by weight of a compound having more than two epoxy groups, and they have also been amended to recite that the use of 100 to 25% by weight of a compound having more than two epoxy groups increases swell.

In this regard, Applicants note that the mixing ratio of di- and tri-epoxy compounds, swell and melt viscosity of the resulting polymer in Examples 1-13 are summarized in following Table.

Example	Epoxy compound				Swell (%)	Melt viscosity (poise)
	di-		tri-			
	(part)	(%)	(part)	(%)		
1	0.6	75	0.2	25	+54	
2	0.6	75	0.2	25	+54	
3	0.6	75	0.2	25	+54	
4	0	0	1.1	100	+112	
5	0	0	1.1	100	+112	
6	0.5	38	0.8	62	+160	
7	0	0	0.7	100	+85	420,000
8	0	0	0.7	100	+85	420,000
9	0.24	40	0.36	60	+77	160,000
10	0	0	0.7	100	+85	420,000
11	0	0	0.7	100	-	
12	0	0	0.7	100	+85	420,000
13	0	0	0.7	100	+77	160,000

Comp.Ex.1	Recycled PET	-23	
Comp.Ex.2	Commercial PET 1	-10	700
Comp.Ex.3	Commercial PET 2	-10	
Comp.Ex.4	Commercial PET 3	+3	2,000
Comp.Ex.5	Commercial PET 4	+3.2	2,230

Support for the increase in swell can also be seen, e.g., in the Disclosure of Invention section beginning at page 5 in the application.

The claims have also been amended to correct improper multiple claim dependencies and to correct a typographical error.

Entry of the above amendments is respectfully requested.

#### **Interview with Examiner**

Applicants thank the Examiner for the personal interview conducted with their representative on January 29, 2004. Applicants believe that the interview was helpful to materially advance the prosecution of the present application.

In the interview, Applicants' representative indicated that Applicants were considering amending the independent claims to state that 100 - 25% of the coupling agent must be of a compound containing more than two epoxy groups (Applicants have now made this amendment). The Examiner suggested that these claims should also be modified to create a nexus between this epoxy group composition and some desired result not taught or suggested by Inokuchi et al. since this reference does teach tri-functional epoxy at column 6, lines 40-43

(Applicants have now adopted the Examiner's suggestion by reciting that the use of 100 to 25% by weight of a compound having more than two epoxy groups increases swell). With respect to the Pfaendner reference, Applicants' representative noted that page 8, last paragraph, discloses that a small amount of mono- or trifunctional epoxy may be present, but urged that this merely indicates allowances for by-produced mono- and trifunctional epoxy compounds and does not recognize the usefulness of trifunctional epoxy compound, as evidenced by the fact that mono- and trifunctional epoxy compounds are treated as equivalents to each other in Pfendner et al. Finally, Applicants' representative briefly discussed the Rule 132 Declaration that Applicants were planning to present.

### **Priority**

On the Office Action Summary, the Examiner has not acknowledged Applicants' claim for priority nor indicated that a copy of the certified copy of the priority document has been received from the International Bureau.

Since priority was claimed in the application transmittal letter filed March 21, 2001, and since the PTO received a copy of the certified copy of the priority document from the International Bureau, Applicants respectfully request that the Examiner acknowledge Applicants' claim for priority and indicate that a copy of the certified copy of the priority document has been received from the International Bureau in the next communication from the PTO.

### **Obviousness Rejection**

Claims 1-8 and 10-14 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Inokuchi et al (4,284,596) in view of Pfaendner et al (WO 94/24188).

In response, Applicants will first explain the present invention in detail and then discuss the prior art relied on by the Examiner.

According to the present invention, by reacting a recycled PET with a selected amount of a compound having more than two epoxy groups in the presence of a metal salt of carboxylic acid, the degree of branching of the long chain, molecular weight, melt viscosity, and swell (degree of swelling) can be controlled as required for foam molding. Because the polyester according to the present invention has long branched chains, and therefore has sufficient "entanglement" in the molecular chains, swell (degree of swelling) and melt viscosity can be increased freely even if the intrinsic viscosity is in the range of as low as 0.6 to 0.8 dl/g.

In the present invention, the use of 0.1-10 parts by weight of a mixture, as a coupling agent, composed of 0-75 percent by weight of a compound having 2 epoxy groups per molecule and 100-25 percent by weight of a compound having containing more than 2 epoxy groups per molecule as described above leads to the coupling reaction of the straight chain polyesters through the epoxy compound to increase the molecular weight. Further, the trifunctional epoxy compound gives rise to an increase in molecular weight and to the formation of a branched structure. These cause not only an increase in molecular weight but also entanglement of the molecule by means of long chain branches thereby bringing increased swell of 5-200% and melt viscosity, and decreased melt flow rate of not more than 50g/10minutes. As a result, smooth foaming from a low to high expansion rate can be attained.



Turning now to the cited art, Applicants note that while Inokuchi et al includes some disclosure of three epoxy groups at column 6, lines 40-43, Inokuchi et al focuses on a process for producing a foamed article through reacting a polyethylene terephthalate with di-glycidyl ether having 2 epoxy groups in a molecule. In this regard, Applicants note that all epoxy compounds employed in Inokuchi's 13 examples are di-epoxy compounds. Applicants submit that there is no teaching or suggestion of the effect of using an epoxy compound having three or more epoxy groups in a molecule as in the present invention.

Applicants also note that a catalyst employed in Inokuchi is sodium montanate. In this regard, Applicants submit that this catalyst cannot be practically used as it renders deep brown coloring.

Thus, Applicants submit that in Inokuchi et al, there is no teaching or suggestion of the production of a long chain blanchd polyethylene terephthalate by using a compound having three or more epoxy groups in a molecule with the effects of attaining increased swell and melt tension due to entanglement of molecules.

As to Phaendner et al, Applicants submit that the method disclosed in this reference achieves an increase in the molecular weight of polyester and recycled polyester by blending a polyester such as PET or PBT (polybutylene terephthalate) with a bifunctional epoxy compound and hydroxyphenylalkyl phosphoric acid ester or half-ester thereof and heating the blend to above the melting point (glass transition temperature) of the polyester. As stated above, Pfaendner et al pays attention only to the bifunctional epoxy compound and is not aware of the usefulness of a trifunctional epoxy compound. At page 8, last paragraph, there is some

description to the effect that a small amount of mono- or trifunctional epoxy may be present, but this only indicates allowances for by-produced mono- and trifunctional epoxy compounds and does not recognize the usefulness of trifunctional epoxy compound. Applicants submit that this is evidenced by the fact that mono- and trifunctional epoxy compounds are treated as equivalents to each other in Pfaendner et al.

Through the use of a di-functional epoxy compound, molecular weight is increased in a linear structure. However, a polymer having a linear structure tends to slide between mutual molecules, and then it cannot increase melt viscosity sufficiently.

In the present invention, 25% by weight or more of a compound having 3 or more epoxy groups is used. This increases the molecular weight and also causes a long chain branched structure. This long chain branched structure, through its entanglement effects, enhances melt viscosity, and then the swell is increased and the foam moldability is improved. This is demonstrated by the Examples of the present invention where melt viscosities of the resulting polymer are 160,000 to 420,000 poise, while those of the comparative polymers are 700 to 2,230 poise, as shown in the Table above.

Applicants submit that Pfaendner et al by no means teaches or suggests such features.

Further, Applicants submit that the hydroxyphenylalkyl phosphinic acid ester or half-ester thereof used in Pfaendner et al is a phosphorus compound, which has toxicity or ichthyotoxicity. Therefore, it cannot be used for containers for food, which is a main use of PET foams.

Moreover, Applicants submit herewith an executed Rule 132 Declaration to further demonstrate the unexpected superiority of the present invention. From the Declaration, it is

apparent that the present invention, in which 25% by weight or more of a trifunctional epoxy compound is used, exhibits a very high swell and melt viscosity.


Thus, Applicants firmly believe that claims 1-8 and 10-14 as amended are not obvious over the cited art combination. Therefore, withdrawal of this rejection is respectfully requested.

### Conclusion

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,



Bruce E. Kramer  
Registration No. 33,725

SUGHRUE MION, PLLC  
Telephone: (202) 293-7060  
Facsimile: (202) 293-7860

WASHINGTON OFFICE

**23373**

CUSTOMER NUMBER

Date: February 2, 2004